Power Quality Solutions

Your essential guide to improving your power quality

NHP Electrical Engineering Products Pty Ltd

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WE'RE EASY TO DO BUSINESS WITH

At NHP we're solely committed to serving the needs of our customers in the industrial electrical industry. From concept design through to installation and after sales service, we are confident we have the experience and expertise to exceed your expectations and ensure you get the best result for your project. How? By combining Partnerships, Agility, Knowledge and Scalability, NHP can offer 100% Australian owned service that forms the ultimate choice in our industry.

PARTNERSHIPS:

When you choose NHP you gain a valuable industry partner. You gain access to an exclusive network of quality global suppliers who, together with NHP, can achieve an engineered solution for your industrial electrical application. A partnership with NHP promises to last, working together with you to offer complete trust, assurance and peace of mind.

KNOWLEDGE:

If your industrial electrical application demands a specialist team of trained project management, design and engineering professionals, then NHP is the ultimate choice, bringing together over 40 years of electrical industry experience and knowledge.

AGILITY:

At NHP we understand your project needs and know that these needs can often change throughout the life cycle of a project. With a seamless combination of local and technical support backed by around the clock service and local stock, NHP has the agility to provide real time solutions where and when you need them.

SCALABILITY:

With all the scale of a large multi-national company, NHP maintain a premium level of customer service and attention to detail no matter how big or small your project. With over 900+ expert staff in over 50+ branch and regional locations, when you deal with NHP you receive all of this combined knowledge and expertise delivered by local people with with a local focus, backed by global suppliers.

Contents

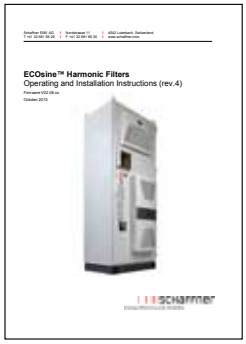
PFCP – Premier, fully modular PFC Solution	4
PFCP Order form	5
PFCE – Economical PFC Solution	6
PFCE Ordering Information	7
PFCW - Wall-mount PFC Solution	8
NHP PFCP functional trays	9
Electronicon LV Capacitors	10
Electronicon MV Capacitors	11
Mangoldt Reactors	12
Beluk Power Factor Regulators	13
Ghisalba Capacitor Switching Contactors	14
ECOsine Active Harmonic Filters	15
ECOsine Passive Harmonic Filters	20
Sine wave filter – FN5040 Series	23
Line Reactor	26
Output Reactor	27
Fuses	28
Service	29
CT'S – For PFC and AHF	30
MCCB selection guide for power factor capacitor application	32

Appendix: Additional information

Power Factor Correction	33
Harmonics	35
Output solutions for motor drives	37

Other useful documents

User Manual
ECOsine™ – Passive Harmonic Filters
Field guide to harmonics mitigation and energy efficiency
Latest edition incl. 690V/50Hz filters



For more information, scan to download the NHP Catalogues App offering exclusive video content, catalogues and literature!

PFCP – Premier, Fully Modular PFC Solution

The PFCP power factor correction system is the premier solution in the PFC family. Offering a fully modular CUBIC design, many different system configurations are possible. Design decisions include: top or bottom cable entry; load-break switch, MCCB or direct connect incomer; standard or advanced controller (with communications); and your choice of colour (RAL 7035 grey standard). The use of functional trays facilitates selectable correction granularity and makes system servicing a breeze.

Standard Features

- Modular design minimises installation time and costs
- Detuning reactors fitted as standard
- IP42 Protection
- Top and Bottom Entry Options
- Choice of incomer: direct connect, load break switch or circuit breaker
- Integral ventilation system
- RAL 7035 grey
- Fully assembled, wired and tested, ready to install and connect

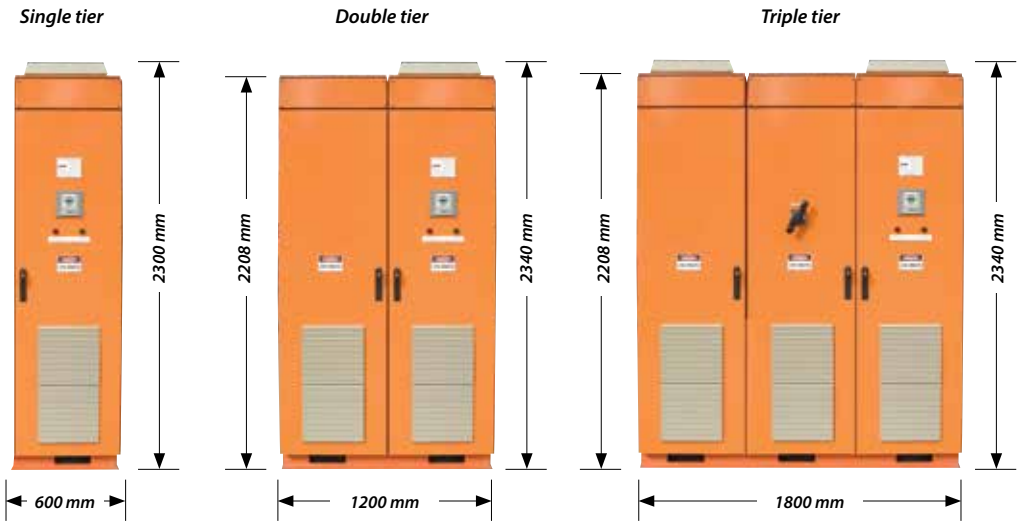
Optional Features

- Communication interface: Modbus over RS485
- Audible warning on fault
- Contact to signal fault
- Height: Shorter heights available on request
- Colour: RAL 2000 Orange or alternative colours available on request

Please scan the QR code to view the fundamentals of Power Factor video

System Sizes

kVAr Range	Incomer Type	No. of Tiers	Available Steps
Up to 300	Load-break and direct connect	1	6
Up to 250	Circuit breaker	1	5
Up to 500	Load-break and direct connect	2	10
Up to 450	Circuit breaker	2	9
Up to 800	Load-break and direct connect	3	16
Up to 750	Circuit breaker	3	15



Power Factor Correction - Premier Order Form

Date:

Customer Account Number:

Customer Company Name:

Contact Name:

Email:

Phone:

NHP Rep / App Engineer:

Project Name:

To manufacture a PFCP system the following minimum information is required.

1. Total kVAr requirement:

2. Step Configuration:

Number of 50 kVAr steps:

Number of 25 kVAr steps:

Number of 12.5 kVAr steps:

Number of 6.25 kVAr steps:

3. Colour (please tick one option):

Grey (RAL 7035) ○

Orange (RAL2000) ○

Other (please specify): ○

Note: Other colours may incur additional cost and lead time

4. Controller:

Basic (BLR-CX): ○

Advanced (BLR-CM): ○

5. Cable Entry:

Top ○

Bottom ○

6. Incomer Type:

Direct connect: ○

Load break switch: ○

Circuit breaker: ○

Scan QR code to download order form

Any other comments / additional requirements?

Power Factor Correction Systems

PFCE – Economical PFC Solution

With economy high on the design criteria, the PFCE delivers a highly economical, standardised PFC system in a compact footprint. Utilising the same high quality components as the PFCP, the PFCE delivers reactive compensation whilst maintaining vital airflow to ensure extended capacitor life.

Standard features

- Quality steel enclosure
- Detuning reactors fitted as standard
- IP32 protection
- Top entry only
- Integral ventilation system
- Direct connect cable entry
- RAL 7035 grey
- Fully assembled, wired and tested, ready to install and connect

Optional features

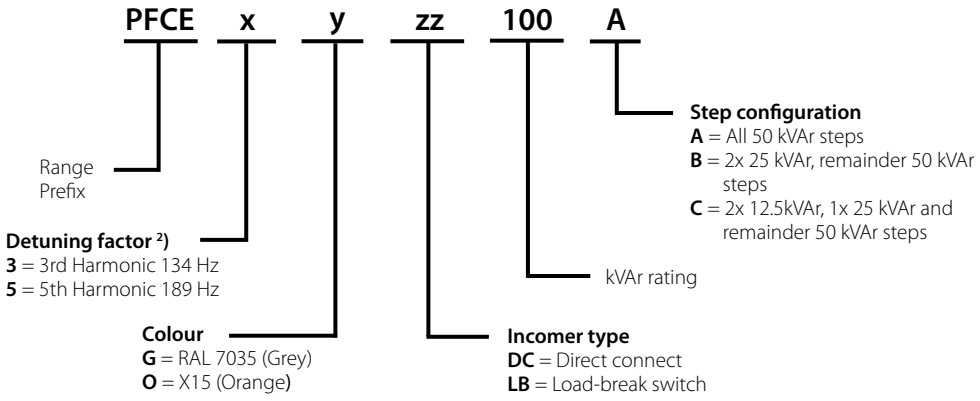
- Load break switch
- Communication interface: Modbus over RS485
- Audible warning on fault
- Contact to signal fault
- X15 orange

3 axial fans/per tier for ventilation
Internal thermostat for temperature control
Beluk PFC
CX controller
Protective casing covering horizontal and vertical busbar
Ghisalba contactors fitted with pre-charge resistors
Harmonic blocking reactors placed at rear, thermally segregated from capacitors
Electronicon capacitors positioned for ease of tong testing, maintenance and replacement.
Wöhner Fuse links fitted for each PFC step.

Power Factor
Correction Systems

PFCE Ordering Information

Part identification


PFCE x y zz 100 A
Range Prefix
Detuning factor 2)
3 = 3rd Harmonic 134 Hz
5 = 5th Harmonic 189 Hz
Colour
G = RAL 7035 (Grey)
O = X15 (Orange)
Incomer type
DC = Direct connect
LB = Load-break switch
kVAr rating
Step configuration
A = All 50 kVAr steps
B = 2x 25 kVAr, remainder 50 kVAr steps
C = 2x 12.5kVAr, 1x 25 kVAr and remainder 50 kVAr steps

Example: PFCE5GDC350B - Grey enclosure, 5th Harmonic blocking, direct connect, 350 kVAr with steps of 6 x 50 and 2 x 25 kVAr

Total KVAr	Step Configuration			Enclosure Size	Catalogue No. [1]
	#50 kVAr steps	#25 kVAr steps	#12.5 kVAr steps		
100	1	2	-	Single door	**PFCExyzz100B**
100	1	1	2	Single door	**PFCExyzz100C**
150	3	-	-	Single door	**PFCExyzz150A**
150	2	2	-	Single door	**PFCExyzz150B**
150	2	1	2	Single door	**PFCExyzz150C**
200	4	-	-	Single door	**PFCExyzz200A**
200	3	2	-	Single door	**PFCExyzz200B**
200	3	1	2	Single door	**PFCExyzz200C**
250	5	-	-	Single door	**PFCExyzz250A**
250	4	2	-	Single door	**PFCExyzz250B**
300	6	-	-	Single door	**PFCExyzz300A**
350	7	-	-	Double door	**PFCExyzz350A**
350	6	2	-	Double door	**PFCExyzz350B**
400	8	-	-	Double door	**PFCExyzz400A**
400	7	2	-	Double door	**PFCExyzz400B**
450	9	-	-	Double door	**PFCExyzz450A**
450	8	2	-	Double door	**PFCExyzz450B**
500	10	-	-	Double door	**PFCExyzz500A**

Notes: [1] Complete Cat. No. by substituting 'x' for detuning factor, 'y' for desired colour, and 'zz' for desired incomer type.
[2] 3rd Harmonic blocking system specifically designed for applications where high triplen harmonics are present in the network or where electrical distributors have embedded communication signals in the supply network. For further information please contact NHP.

PFCW - Wall-mount PFC Solution

Complementing the floor standing PFC solutions is the wall-mountable PFCW PFC system.

The PFCW offers reactive compensation from 50kVAr up to 100kVAr, all in a compact enclosure.

Ideal for installations where floor space comes at a premium, such as inner city locations and Commercial estates.

Features:

- Top cable entry
- Load break switch
- Detuning reactors fitted as standard (189Hz)
- IP31
- Integral ventilation system
- Fully assembled, wired and tested, ready to install and connect
- Overall dimension (H x W x D): 1000mm x 800mm x 447mm

PFCW Ordering Information

Total installed kVAr	kVAr stages	Catalogue No.
50kVAr	50kVAr 2 x 25kVAr	**PFCW502S**
50kVAr	50kVAr 1 x 25kVAr 2 x 12.5kVAr	**PFCW503S**
62.5kVAr	62.5kVAr 2 x 25kVAr 1 x 12.5kVAr	**PFCW623S**
75kVAr	75kVAr 3 x 25kVAr	**PFCW753S**
87.5kVAr	87.5kVAr 3 x 25kVAr 1 x 12.5kVAr	**PFCW874S**
100kVAr	100kVAr 4 x 25kVAr	**PFCW1004S**

NHP PFCP Functional Trays

The NHP PFCP functional trays are available for assembly of new PFC systems or the augmentation of existing systems. With the PFCP functional trays you have a choice of module ratings, including 50, 25, 12.5 or 6.25 kVAr. This granularity in module rating gives you the flexibility to tailor make a PFC system to suit your particular application.

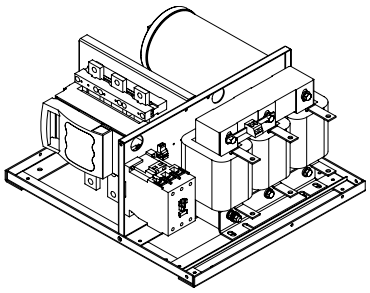
Advantages of NHP PFCP functional trays

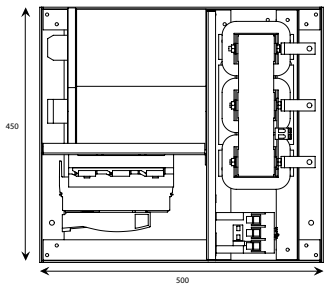
- Modular design for easy installation and removal
- High quality components including Electronicon capacitors, Mangoldt reactors, Ghisalba capacitor switching contactors
- 189Hz de-tuned reactors fitted as standard
- Over temperature cut-out intergral to harmonic blocking reactor, used to isolate module in over-temperature condition
- Thermal segregation between capacitor and reactor
- Compact design – suits 600mm cubicle width, ideal for Cubic, Eldon or custom enclosures. Fuse disconnector included as standard

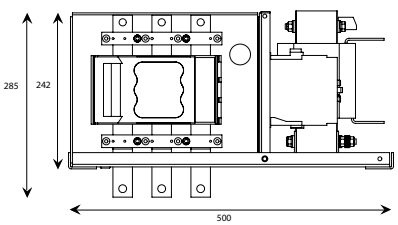
PFCP Functional Trays Ordering Information [1])

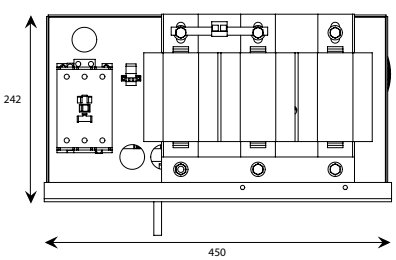
Total installed kVAr @ 415 V AC	Nominal	Rated Current (A)	Total Losses at Fundamental Current (W)	Fuse (A)	Catalogue No.
6.25	415	9	32	16	**FTSR6CQE**
12.5	415	17.5	63	32	**FTSR12CQE**
25	415	35	125	63	**FTSR25CQE**
50	415	70	250	125	**FTSR50CQE**

Note: [1]) PFCP function trays also available with circuit breaker fitted (instead of fuse disconnector). Add "CB" to complete part No. ie. FTSR50CQECB







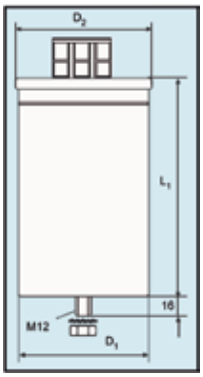


Electronicon Capacitors

LV Capacitors for Power Factor Correction

Features

- Gas filled capacitors (N_2)
- Self healing dielectric
- Over pressure device
- Touch proof terminals
- Single mount stud
- Modular resistor block
- Environmentally friendly – does not contain PCB s
- Wave like edge on the dielectric



Technical Information

• Temperature range/class	-40° C to IEC831 Class C/D
• Internal connection	Delta
• Rated frequencies	50Hz / 60Hz
• Tolerance of capacitance	±5%
• Filling material	Nitrogen Gas
• Protection against accidental contact	IP 20 terminals
• Capacitor losses (total capacitor)	0.25-4 W/k VAr

Nominal voltage: 525V 50Hz

kVAr @ 415V AC	kVAr @ 525V AC	Cn (µF)	In	Imax	Dimensions D1(D2) x L1 (mm)	Weight (kg)	Resistor Module	Catalogue No.
6.25	10	3 x 38	3 x 11	3 x 18	75 (79.5) x 230	1.0	Included with Capacitor	**275.546-703803**
12.5	20	3 x 77	3 x 22	3 x 36	100 (104.5) x 230	1.7	275.106-10180	**275.176-707700**
15.6	25	3 x 96	3 x 28	3 x 50	116 (120.5) x 230	2.3	275.106-10180	**275.186-809600**
25	40	3 x 154	3 x 44	3 x 72	136 (140.5) x 245	3.7	275.106-10120	**275.398-715401**

Nominal voltage: 800V 50Hz

kVAr @ 690V AC	kVAr @ 800V AC	Cn (µF)	In	Imax	Dimensions D1(D2) x L1 (mm)	Weight (kg)	Resistor Module	Catalogue No.
12.5	16.7	3 x 28	3 x 12	3 x 19	95 (99.5) x 230	1.5	275.106-10180	**275.166-502800**
25	31.2	3 x 52	3 x 23	3 x 34	136 (140.5) x 230	2.9	275.106-10120	**275.196-505200**

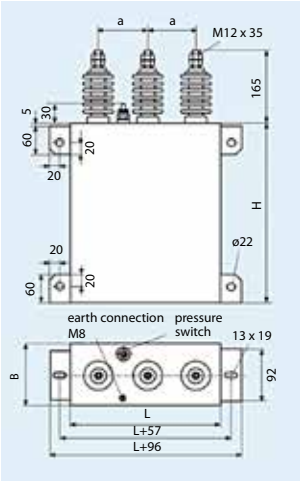
Note: * Other capacitors available on request

Electronicon Capacitors

MV Capacitors for Power Factor Correction

Features

- Gas filled capacitors
- Self healing dielectric
- Pressure monitor
- Temperature class -40º C to IEC 831 C/D
- Delta connected with integrated discharge resistor
- Low loss rating < 0.25 w/kVAr
- Stainless steel housing painted RAL 5019
- Ceramic insulators with M12 x 35 threaded studs
- Capacitors do not produce asymmetries – therefore: no need to monitor star point
- Single phase MV reactors also available



Nominal voltage: 3300V 50Hz

Q (kVAr)	C (uF)	In (A)	Temp Category	Dimensions L x B x H (mm)	a (mm)	Weight (kg)	Catalogue No.
100	3 x 29.2	3 x17.5	D	340 x 125 x 425	129	23	**E90.C42-293300**
200	3 x 58.5	3 x 35	C	415 x 150 x 455	158	40	**E90.G45-593300**
300	3 x 87.7	3 x 52.5	B	415 x 150 x 585	158	43	**E90.G58-883300**

Nominal voltage: 6600V 50Hz

Q (kVAr)	C (uF)	In (A)	Temp Category	Dimensions L x B x H (mm)	a (mm)	Weight (kg)	Catalogue No.
100	3 x 7.3	3 x 8.7	D	340 x 125 x 425	129	23	**E90.C42-732300**
200	3 x 14.6	3 x 17.5	D	415 x 150 x 455	158	40	**E90.G45-153300**
300	3 x 21.9	3 x 26.2	C	415 x 150 x 585	158	43	**E90.G58-223300**

Nominal voltage: 11000V 50Hz

Q (kVAr)	C (uF)	In (A)	Temp Category	Dimensions L x B x H (mm)	a (mm)	Weight (kg)	Catalogue No.
150	3 x 4.0	3 x 7.9	D	415 x 150 x 455	158	40	**E90.G45-402301**
250	3 x 6.6	3 x 13.1	D	415 x 150 x 585	158	43	**E90.G58-662300**
300	3 x 7.9	3 x 15.7	D	415 x 150 x 585	158	43	**E90.G58-792300**
400	3 x 10.5	3 x 21.0	C	415 x 150 x 715	158	53	**E90.G71-113302**

Nominal voltage: 12000V 50Hz

Q (kVAr)	C (uF)	In (A)	Temp Category	Dimensions L x B x H (mm)	a (mm)	Weight (kg)	Catalogue No.
150	3 x 3.3	3 x 7.2	D	415 x 150 x 455	158	40	**E90.G45-332300**
250	3 x 5.5	3 x 12.0	D	415 x 150 x 585	158	43	**E90.G58-552301**
300	3 x 6.6	3 x 14.4	D	415 x 150 x 585	158	43	**E90.G58-662301**
400	3 x 8.8	3 x 19.4	C	415 x 150 x 715	158	53	**E90.G71-882300**

Mangoldt Reactors

These high quality reactors are connected in series with the capacitor and this arrangement is tuned to 189 Hz (7% detuning factor) for the purpose of blocking 5th order harmonics and above as well as reducing inrush currents and preventing harmonic resonance.

The reactors are completely impregnated under vacuum in a thermosetting polyester resin to insulation/temperature Class H, and then dried in a furnace. They also include temperature cut out switches to protect the associated capacitor if high harmonics are present.
The reactors are included as standard on all NHP PFC functional trays. Other size Mangoldt reactors (including medium voltage reactors) are also available

Features

- Type: dry, open terminals
- Temperature class H
- Temperature cut out switches provided
- De-tuned capacitor banks help protect capacitors from the harmful effects of harmonics and inrush currents
- Medium Voltage reactors also available

Tuning frequency 189Hz, detuning factor 7%

Nominal Voltage (V)	Capacitor Output kVAr	Inductance (per line)	Current (A)	Watts loss @fundamental	Dimensions H x W x D (mm)	Weight (kg)	Catalogue No.
400/415	6.25	7 mH	11	40	140 x 130 x 90	4	**HR6**
400/415	12.5	3.084 mH	21.1	99	170 x 230 x 150	11	**MHR12**
400/415	25	1.542 mH	42.1	165	205 x 230 x 150	18	**MHR25**
400/415	50	0.771 mH	84.2	265	240 x 265 x 165	29	**MHR50**

Mangoldt Medium Voltage Reactors

A range of MV filter reactors, MV blocking reactors for capacitor banks, MV compensating (shunt) reactors, and MV damping/current limiting reactors are also available from Mangoldt.

For more information please contact your local NHP sales representative.

Beluk Power Factor Regulators

BLR-CX Standard PFC Controller

Features

- LCD display for cosφ and parameters including step status
- Measurement display for U, I, P, Q, S, THDU, F, T
- 1-phase measurement system also suitable for non-sinusoidal currents and voltages
- Supply voltage 240V AC, 50Hz
- Current measuring 15mA – 6 A, suitable for CT x/1 A and x/5 A
- Screw type terminals
- Alarm relay with volt-free contact
- Protection class IP20 (casing), IP50 (front)

Ordering Information - CX

No. of steps	Instrument case cut out (mm)	Catalogue No.
6	138 x 138, depth 58	**BLRCX06R**
12	138 x 138, depth 58	**BLRCX12R**

Accessories – IP54 relay cover

IP54 Relay cover	Catalogue No.
IP54 Relay cover suitable for both CX and CM controller	**PFCRELAYCOVER**

BLR-CM Advanced PFC Controller

Features

- RS485 interface for communication via MODBUS
- Graphical LCD display of step status, measurement values and system data
- Measurement display for U, I, P, Q, S, THDU, THDI, ΔQ, F, T
- Harmonic measurement for voltage and current up to the 31st order
- 1-phase measurement system also suitable for non-sinusoidal currents and voltages
- Supply voltage 240V AC, 50Hz
- Current measuring 10mA – 5A, suitable for CT x/1 A and x/5 A
- Flexible alarm system with up to 15 alarms
- Programmable digital input and digital output
- Protection class IP20 (casing), IP54 (front)

Ordering Information - CM

No. of steps	Instrument case cut out (mm)	Catalogue No.
6	137 x 138, depth 54	**BLRCM06RMB**
12	137 x 138, depth 54	**BLRCM12RMB**

BELUK

Ghisalba Capacitor Switching Contactors

The switching conditions are particularly stressful in capacitor bank installations due to the presence of high peak currents. Standard contactors can weld or have their life significantly reduced due to the high inrush currents. Inrush currents also stresses the capacitor and reduces the lifespan.

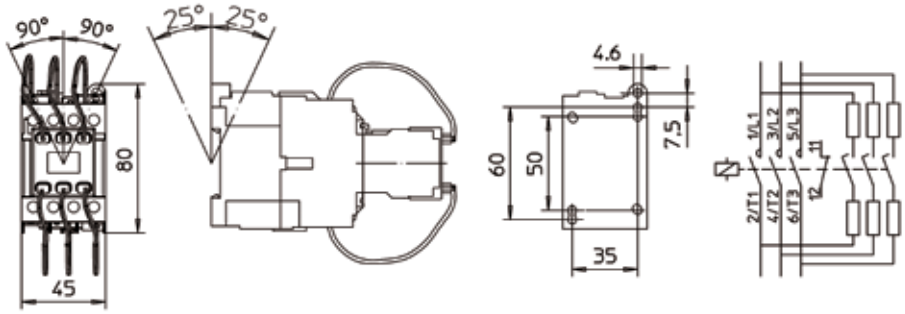
Features

- Fitted with early make snap action contact block linked with resistors
- Reduces inrush currents
- Reduces capacitor stress and extends capacitor lifespan
- Prevents contactor welding
- GH15-RF contactors of category AC6b

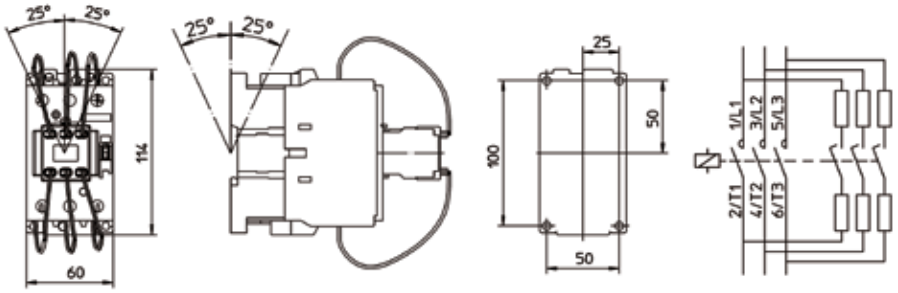
GH15-RF Ordering Information

kVAr @ 400/415V	Auxiliary contacts fitted	Maximum fuse rating (A)	Catalogue No.
15	1 N/O + 1 N/C	40	**GH15-RF1-240VAC**
30	1 N/O	80 (63)	**GH15-RF3-240VAC**
50	1 N/O	125	**GH15-RF5-240VAC**

GH15-RF1



GH15-RF3 – GH15-RF5



ECOsine™ Active Harmonic Filters

Active harmonic filtering (AHF) is the process by which an adaptive waveform is injected back into the network corresponding to the exact shape of the non linear portion of the load current. The AHF introduces this adaptive current into the load at the point of connection. Unlike passive harmonic filters, these filters can provide harmonic mitigation under any load conditions up to their rated capacity and 4 wire versions can compensate both single phase and three phase non-linear loads.

Features

- Reduces THID to 1.5% - 3% (typical)
- Response time: less than 300 µs
- Multiple functions – harmonic filtering, reactive power compensation and load balancing
- Can target individual harmonics up to 49th harmonic
- Optimised for maintenance
- IP20 for 30-120A models (optional IP54), IP54 standard for 200-300A models
- 3-wire and 4-wire units available
- Automatically adapts to changing network topologies.
- Interfaces: Modbus RTU (RS485), Modbus TCP/IP (Ethernet)
- AHF Viewer – Easy to use software for measurement, monitoring etc.
- New 690V Active harmonic filter available

ECOsine Active Ordering Information

Rated Compensation Current (A)	3 or 4 wire	Dimensions W x H x D (mm)	Weight (kg)	External Fuse (cable protection fuses, e.g. type gL/gG)	IP rating (standard)	Catalogue No.
30	3 wire	360 x 590 x 290	47	50 A	IP20 [2])	**FN3420304803**
	4 wire	415 x 840 x 300	70	50 A	IP20 [2])	**FN3430304004**
50	3 wire	360 x 590 x 290	47	80 A	IP20 [2])	**FN3420504803**
60	4 wire	415 x 840 x 300	70	100 A	IP20 [2])	**FN3430604004**
100	3 wire	468 x 970 x 412	105	160 A	IP20 [2])	**FN34201004803**
	4 wire	468 x 1460 x 412	145	160 A	IP20 [2])	**FN34301004004**
120	3 wire	468 x 970 x 412	105	200 A	IP20 [2])	**FN34201204803**
	4 wire	468 x 1460 x 412	145	200 A	IP20 [2])	**FN34301204004**
200	3 wire	800 x 2000 x 600	440	400 A [1])	IP54	**FN34202004803**
	4 wire	800 x 2000 x 600	525	400 A [1])	IP54	**FN34302004004**
250	3 wire	800 x 2000 x 600	440	400 A [1])	IP54	**FN34202504803**
	4 wire	800 x 2000 x 600	525	400 A [1])	IP54	**FN34302504004**
300	3 wire	800 x 2000 x 600	440	400 A [1])	IP54	**FN34203004803**
	4 wire	800 x 2000 x 600	525	400 A [1])	IP54	**FN34303004004**

Notes: [1]) Internal 400 A fuse block supplied with ECOsine™ Active 200/250/300A
[2]) Higher IP solution can be provided - NHP value add solution

690 VAC ECOsine™ Active Ordering Information

Rated Current (A)	(A)3 or 4 wire	Dimensions W x H x D (mm)	Weight (kg)	External Fuse	IP rating (standard)	Catalogue No.
200	3 wire	800 x 2000 x 600	520	Refer NHP	IP54	**FN34202006903**

Please scan to view the Active Harmonic Filtering video.

ECOsine™ Active Harmonic Filters

ECOsine™ Active 30/50A

ECOsine™ Active 30/50A (3 wire)

– The compact and easy-to-install filter

The smallest ECOsine™ Active version is ideal for the reliable compensation up to the 50th harmonic, as well as reactive power, in a targeted manner. Due to its compact dimensions and low weight, this filter can be easily installed in any environment. Both wall and cabinet installations are possible offering IP20 protection as standard with IP54 optional. Not only space-saving, it is also economical in terms of power loss with only 1300W. With a response time of under 300 µs in ultra-fast mode, it is also possible to optimally compensate dynamic loads. A higher power level can be easily attained by paralleling up to 5 units.

ECOsine™ Active 100A

ECOsine™ Active 30/60A (4 wire)

– The solution for building technology

This ECOsine™ Active version mitigates harmonics on all three phases as well as the neutral wire and is particularly useful for the reliable compensation of the triple harmonics up to the 50th order. This compact package is the ideal system for commercial type installations where switch-mode power supplies and information technology equipment are common sources of harmonic generation.

ECOsine™ Active 200/250/300A

ECOsine™ Active 100/120A

– The standard for 3 and 4 wire technology is always the perfect fit

Only marginally larger and heavier than the 30/50A system, the 100A unit can deal with twice the current. It is the perfect solution for those who need greater performance. The 4 wire unit also allows for compensation on the neutral conductor.

ECOsine™ Active 200/250/300A

– The industrial model is a real power pack

With up to 300A of compensating current, this filter remains fully capable for the highest requirements such as large production facilities, like those found in the automotive industry. The cabinet version comes with forced air cooling, as well as internal liquid cooling for the power electronics including an integrated water/air heat exchanger. These powerful units are available in either 3-wire or 4-wire units and come with a protection class of IP54.

ECOsine™ AHF Parallel Operation

The available compensation current can be increased through parallel operation of several ECOsine™ Active units. In doing so, the current signal from the external current transformers is looped through all the ECOsine™ Active units in accordance with the following schematic. The current transformers must be installed on load side (between the mains connection of the filter and the mains connection of the load to be compensated).

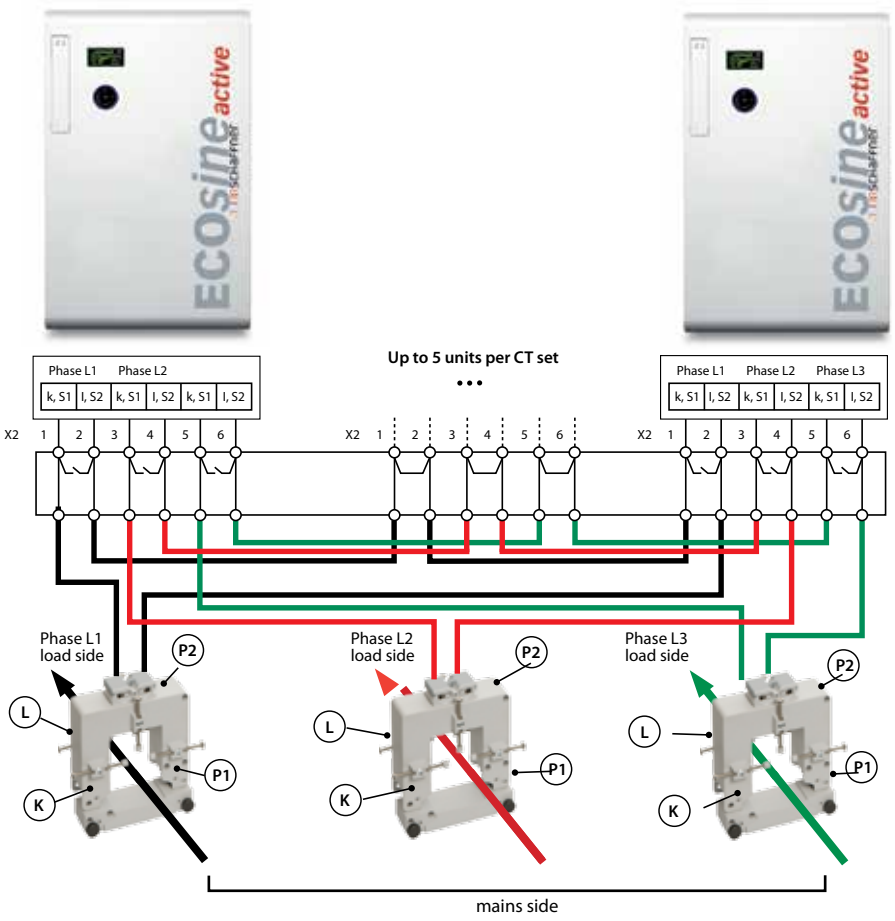


Figure 7. Current transformer wiring for parallel operation of up to five ECOsine™ Active

Notes: A maximum of five ECOsine™ Active may be operated on one current transformer set due to the maximum power output of the external current transformers. Additional current transformers must be installed if more than five devices are to be operated in parallel. For parallel operation of more than one ECOsine™ Active the current transformers must be installed on load side of the filter.

Control elements are easy to remove

Modules (filter unit and power element) can be released from the front with just a few bolt/ plug connections

Liquid cooling can be disconnected quickly and without any spilling using quick-release couplings

Modules can be popped out towards the front

Minimal time-to-repair thanks to a modular design (MTTR <15 minutes).

The ready-for connection industrial cabinet unit is modular in design with each individual module easily accessible and removable from the front of the cabinet.
An MTTR value of <15 minutes with an MTBF value of up to 100,000 hours provides for the fastest service times and long maintenance intervals

Integrated heat exchanger (water/air)
Control elements (controller) with a well-lit, energy saving display and large range of view
Filter unit
DC bus with power semiconductors
Forced air cooling
Fuse block (fuses can be individually removed from the holder)
Self-sealing hydraulic quick disconnect

ECOsine™ Active provides

- Reliability: eliminates all relevant disturbance patterns in the power lines
- Cost-savings: avoids/reduces wear on electrical loads and over-heating of cables and transformers
- Efficiency: prevents losses due to production downtimes
- Flexibility: constantly adapts to the network topology
- Fast response time: compensates disturbances before they can cause damage
- Economy: lowers energy cost through reduced reactive power demand
- Compact dimensions: requires very little space compared to traditional solutions
- Ruggedness: provides protection according to IP54
- Effortless: simple installation and intuitive operation.

ECOsine™ Active Harmonic Filters

Technical data

FN 3420-.. FN 3430-..	3-wire 4-wire	..-30-480-3 ..-30-400-4	..-50-480-3 -	- ..-60-400-4	..-100-480-3 ..-100-400-4	..-120-480-3 ..-120-400-4	..-200-480-3 ..-200-400-4	..-250-480-3 ..-250-400-4	..-300-480-3 ..-300-400-4
Rated comp. current	3-wire	30A	50A	-	100A	120A	200A	250A	300A
	4-wire	30/90A	-	60/180A	100/300A	120/360A	200/600A	250/750A	300/750A
Switching frequency		16 kHz							
Overload capability [1]		75A for 10ms	125A for 10ms	150A for 10ms	250A for 10ms	250A for 10ms	500A for 10ms	625A for 10ms	750A for 10 ms
Cooling type		Forced air cooling					Forced air cooling (internal liquid cooling)		
Ambient temperature		0 - 40 ° C [3]		0 -30 ° C [3]	0 - 40 ° C	0 - 30 ° C [2] [3]	0 - 40 ° C [3] (FN3430-300-400-4 is 0-30°C [4])		
Parallel operation		Up to 5 units							
Interfaces		Modbus RTU (RS485), Modbus TCP/IP (Ethernet)							
Power loss	3-wire	< 900W	< 1300W	-	< 2200W	< 2500W	< 5000W	< 6000W	< 7500W
	4-wire	< 950W	-	< 1800W	< 3000W	< 3000W	< 5500W	< 6300W	< 8500W
Noise level (1m)	3-wire	65dBA	65dBA	-	68dBA	68dBA	70dBA	70dBA	70dBA
	4-wire	63dBA	-	63dBA	69dBA	69dBA	70dBA	70dBA	70dBA
Filter performance		Up to the 50th order							
Altitude		1,000m / de-rating up to 4,000m, 1% / 100m							
Mains Voltage	3-wire	380V (AC) ± 15% … 480V (AC) ± 10%					380 (AC) ± 15% … 415V (AC) ± 10%		
	4-wire	380V (AC) ± 15% … 415V (AC) ± 10%					380 (AC) ± 15% … 415V (AC) ± 10%		
Mains frequency		50 Hz ± 5%					50 Hz ± 5%		
Response time		300 µs							
Controller topology		Digital with FFT analysis							
Current limitation		Normal Current							
Current transformer		50 : 5 to 50,000 : 5							
Dimensions (w x h x d) (mm)	3-wire	360 x 590 x2 90	360 x 590 x 290	-	468 x 970 x 412	468 x 970 x 412	800 x 2000 x 600 Height plus socket (200 mm standard), depth including heat exchanger 760 mm		
	4-wire	415 x 840 x 300	-	415 x 840 x 300	468 x 1460 x 412	468 x 1460 x 412			
Weight	3-wire	47kg	47kg	-	105kg	105kg	440kg	440kg	410kg
	4-wire	70kg	-	70kg	145kg	145kg	525kg	525kg	52 5kg
Protection class		Standard IP20, optional IP54					IP54		
Approval		C - tick							

[1] Peak Value

[2] Derating up to 40°C, 1.2%/K

[3] Derating up to 50°C, 2%/K

[4] Derating up to 40°C, 1.7%/K

For more information on Harmonic Filters please contact your local NHP branch

ECOsine™ - Passive Harmonic Filters

FN3410 for diode rectifiers

Schaffner ECOsine™ passive harmonic filters represent an economical solution to the challenge of load applied harmonic mitigation in three-phase power systems. These filters are designed for the operation on the line side of power electronic equipment with diode rectifiers (FN3410...) in balanced three-phase power systems.

Features

- Reduces THID of standard variable speed drive to 5-8%
- More compact dimensions to comparable products
- Quick Installation
- Easily commissioned
- Very efficient (98.5 to 99.5% depending upon the model)
- FN3410-10 to FN3410-110 are wall mount, FN3410-150 to FN3410-320 are floor mount
- IP20 (except 200 kW and above)
- New FN3416 ECOsine™ Economy Line (THID 10%) available upon request
- FN3410HV 690V AC models available upon request

Note: * Low harmonics drive solutions are also available.
Please contact 1300 NHP NHP for further information.

Part number coding

FN 34xx - xxx - xx

Schaffner standard filter range

Filter family
3410 = filter for 50 Hz, 380-500V

Rated, unfiltered load (drive input) current [A]

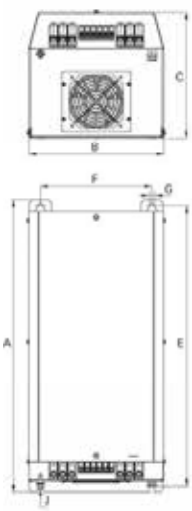
Connection Style
33 = safety terminal block 16 mm² max
34 = safety terminal block 35 mm² max
35 = safety terminal block 50 mm² max
40 = safety terminal block 95 mm² max
44 = safety terminal block 10 mm2 max
99 = copper bus bars

ECOsine™ PHF Ordering Information - For diode rectifiers (ie. 6 pulse VSDs)

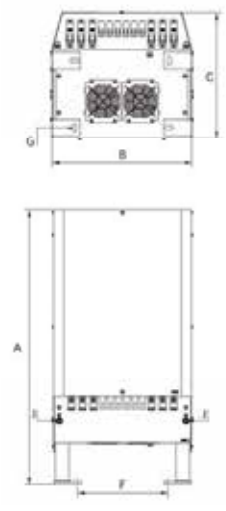
Rated Load Power @ 400 VAC / 50Hz (kW)	Rated Load Current @ 400 VAC / 50Hz (A)	Standby Losses (W)	Loaded Loss(W)	Dimensions H x W x D (mm)	Weight (kg)	Catalogue No.
4	10	0.8	60	400 x 170 x 190	13	**FN 3410-10-44**
5.5	13	0.8	83	400 x 170 x 190	14	**FN 3410-13-44**
7.5	16	0.9	113	430 x 210 x 210	21	**FN 3410-16-44**
11	24	0.9	165	520 x 250 x 280	27	**FN 3410-24-33**
15	32	1.8	225	520 x 250 x 280	31	**FN 3410-32-33**
18.5	38	1.8	259	520 x 250 x 280	35	**FN 3410-38-33**
22	45	1.8	286	590 x 300 x 300	45	**FN 3410-45-34**
30	60	2.9	360	590 x 300 x 300	54	**FN 3410-60-34**
37	75	2.9	407	750 x 320 x 300	65	**FN 3410-75-35**
45	90	4.1	450	750 x 320 x 300	77	**FN 3410-90-35**
55	110	4.1	495	750 x 320 x 300	86	**FN 3410-110-35**
75	150	5.7	600	1000 x 500 x 450	118	**FN 3410-150-40**
90	180	6.6	630	1000 x 500 x 450	136	**FN 3410-180-40**
110	210	7.8	770	1000 x 500 x 450	154	**FN 3410-210-40**
132	260	8.2	792	1000 x 500 x 450	201	**FN 3410-260-99**
160	320	8.6	960	1000 x 500 x 450	201	**FN 3410-320-99**
200	380	[1])	[1])	[1])	[1])	**FN 3410-380-99-0 [1])**
250	470	[1])	[1])	[1])	[1])	**FN 3410-470-99-0 [1])**
315	580	[1])	[1])	[1])	[1])	**FN 3410-580-99-0 [1])**
355	650	[1])	[1])	[1])	[1])	**FN 3410-650-99-0 [1])**
400	710	[1])	[1])	[1])	[1])	**FN 3410-710-99-0 [1])**

Dimensions

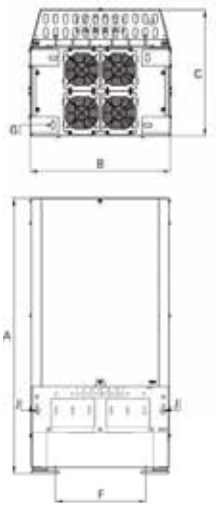
FN 3410-10 to 110



FN 3410-150 to 210

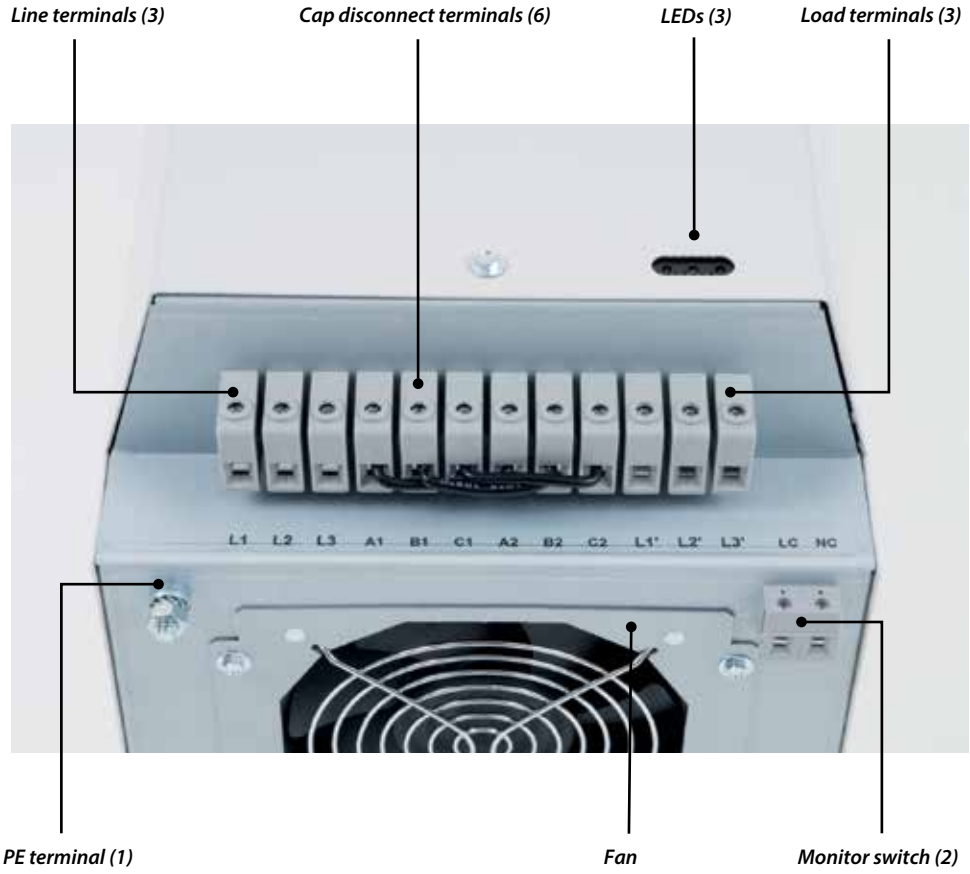


FN 3410-260 and 320



Notes: [1]) Unit is delivered in component form consisting of choke modules, capacitor modules and damper modules. Detailed information regarding the weights, losses, dimensions and required connections can be provided upon request.

External Filter Elements


Line terminals (3)
Cap disconnect terminals (6)
LEDs (3)
Load terminals (3)
L1 L2 L3 A1 B1 C1 A2 B2 C2 L1' L2' L3' LC NC
PE terminal (1)
Fan
Monitor switch (2)

Monitoring Status

LEDs	Monitor switch	Filter state
		Power off
		Power on, internal temperature does not require fan
		Power on, active fan cooling
		Power on, over-temperature or fan error *
		Power on, sensor short or monitor error

* Fan or sensor disconnection is recognised

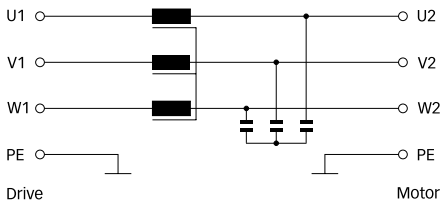
Sine Wave Filter – FN5040 Series

The Schaffner sine wave filter (FN5040) converts the rectangular PWM output voltage of motor drives into a smooth sine wave with low residual ripple

Features and benefits

- Smooth sine wave without voltage peaks
- Motor protection against pulse pattern stress
- Reduce bearing currents
- Improvement of system reliability
- Motor cable length: Up to 2000m (depending upon current)
- Motor frequency up to 200Hz
- FN5040HV 690V AC models available upon request
- FN5045 IP20 models available upon request

Typical electrical schematic



(400 V) FN5040 Sine Wave Filter Ordering Information

Rated current @ 45°C/50Hz (A)	Typical drive power rating (kW)	Typical power loss (W)	Dimensions H x W x D (mm)	Weight (kg)	Min. Switching frequency (kHz)	Catalogue No.
4.5	1.1/1.5	65	171 x 126 x 77	3.3	4	**FN 5040-4-82**
8	2.2/3	80	212 x 155 x 84	4.6	4	**FN 5040-8-82**
10	4	90	208 x 155 x 94	6.1	4	**FN 5040-10-83**
17	5.5/7.5	115	224 x 190 x 115	7.8	4	**FN 5040-17-83**
24	11	150	224 x 190 x 116	14.4	4	**FN 5040-24-84**
38	15/18.5	170	275 x 230 x 151	25.0	4	**FN 5040-38-84**
48	22	260	355 x 300 x 171	34.0	4	**FN 5040-48-85**
62	30	280	395 x 320 x 190	36.0	3	**FN 5040-62-86**
75	37	330	395 x 305 x 240	42.0	3	**FN 5040-75-87**
115	45/55	500	495 x 305 x 236	68.0	3	**FN 5040-115-87**
180	75/90	680	Refer to datasheet	86.0	3	**FN 5040-180-99**
260	110/132	880	Refer to datasheet	125.0	3	**FN 5040-260-99**
410	160/200	1100	Refer to datasheet	184	3	**FN 5040-410-99**
480	250	1350	Refer to datasheet	235.0	3	**FN 5040-480-99**
660	315/355	2000	Refer to datasheet	310.0	2	**FN 5040-660-99**
750	400	2800	Refer to datasheet	470.0	2	**FN 5040-750-99**
880	450/500	3400	Refer to datasheet	640.0	2	**FN 5040-880-99**
1200	560/630	3800	Refer to datasheet	680.0	2	**FN 5040-1200-99**

(690V) FN5040HV Sine Wave Filter Ordering Information

Rated current @ 45°C/50Hz (A)	Typical drive power rating (kW)	Typical power loss (W)	Weight (kg)	Min. Switching frequency (kHz)	Catalogue No.
13	Up to 7.5	170	12	2	**FN 5040HV-13-83**
28	11 to 22	280	30	2	**FN 5040HV-28-84**
45	30/37	360	45	2	**FN 5040HV-45-85**
75	45/55	500	75	2	**FN 5040HV-75-87**
115	75/90	850	120	2	**FN 5040HV-115-87**
165	110/132	1100	165	2	**FN 5040HV-165-99**
260	160/200	1200	220	2	**FN 5040HV-260-99**
300	250	1600	240	2	**FN 5040HV-300-99**
430	315/400	2000	330	1.5	**FN 5040HV-430-99**
530	500	2400	430	1.5	**FN 5040HV-530-99**
660	560/630	2900	590	1.5	**FN 5040HV-660-99**
765	710	3800	690	1.5	**FN 5040HV-765-99**
940	800/900	3400	700	1.5	**FN 5040HV-940-99**
1320	1000/1200	4700	740	1.5	**FN 5040HV-1320-99**

Required settings on Drives when using sine wave filters

Ensure the drive's switching frequency is set to the required minimum switching frequency (refer to tables above and technical datasheets). Higher frequencies are allowed.

The mode of operation must be "scalar" (V/Hz).

Please check the inverter manual whether special settings are necessary.

Note:

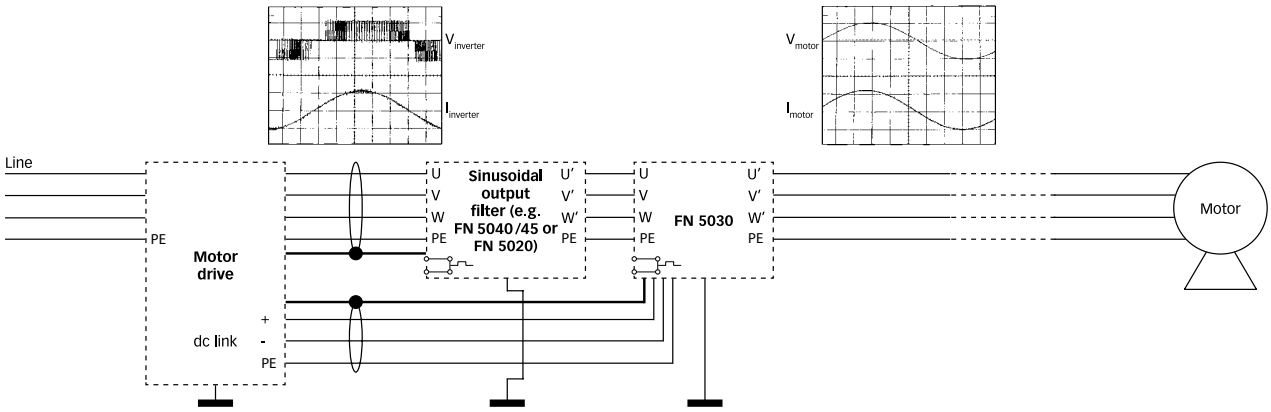
If the inverter settings are not in accordance the filter may be damaged.

Sine wave filter Plus – Add on Module

Features

- Additional module for use with FN 5020 sine wave filters only
- For motor frequencies up to 600Hz
- Reduction of common-mode interferences on motor cables
- Improvement of EMC environment
- Elimination of motor bearing damages
- Possibility to use very long unshielded motor cables
- Improvement of system reliability.

Typical block schematic



FN5030 Sine Wave Filter Plus Ordering Information

Rated Current @ 50°C (A)	Typical drive power rating (kW)	Dimensions H x W x D (mm)	Weight (kg)	Catalogue No.
25	15	162 x 200 x 310	13	**FN 5030-25-33**
55	30	200 x 250 x 354	14	**FN 5030-55-34**
75	45	283 x 343 x 434	27	**FN 5030-75-35**
120	75	283 x 343 x 434	40	**FN 5030-120-35**

Line Reactor

Features and benefits

- Provision of 4% impedance
- Reduction of mains harmonics
- Reduction of commutation notches
- Protection of motor drive electronics
- Limitation of inrush currents
- Improvement of true power factor

Line Reactor Ordering Information

Rated Current @ 40°C (A)	Typical drive power rating (kW)	Power Loss @ 25° C/50 Hz (W)	Dimensions H x W x D (mm)	Weight (kg)	Catalogue No.
4	1.5	23	max.115 x max.70 x 100	2.1	**RWK 212-4-KL**
7	3	36	max.130 x max.80 x 125	2.5	**RWK 212-7-KL**
11	4	37	max.130 x max.80 x 125	2.5	**RWK 212-11-KL**
16	7.5	59	max.155 x max.80 x 155	3.9	**RWK 212-16-KL**
21	11	66	max.155 x max.95 x 155	5.4	**RWK 212-21-KL**
29	15	69	max.155 x max.95 x 155	5.4	**RWK 212-29-KL**
35	18.5	70	max.170 x max.105 x 155	5.9	**RWK 212-35-KL**
46	22	99	max.195 x max.120 x 190	11	**RWK 212-46-KL**
60	30	138	max.240 x max.155 x 210	15	**RWK 212-60-KL**
75	37	133	max.249 x max.160 x 210	15	**RWK 212-75-KL**
95	45	166	max.275 x max.185 x 230	22	**RWK 212-95-KL**
124	55	172	max.210 x max.210 x 240	25	**RWK 212-124-KS**
156	75	249	max.210 x max.210 x 240	25	**RWK 212-156-KS**
182	90	245	max.230 x max.210 x 265	32	**RWK 212-182-KS**
230	110/132	301	270 x 210 x 300	35	**RWK 212-230-KS**
280	160	335	270 x 218 x 300	41	**RWK 212-280-KS**
330	160	386	270 x 255 x 300	56	**RWK 212-330-KS**
400	200	692	390 x 205 x 420	57	**RWK 212-400-S**
500	250	761	390 x 215 x 420	67	**RWK 212-500-S**
600	315	825	390 x 225 x 420	76	**RWK 212-600-S**
680	355	876	390 x 225 x 420	80	**RWK 212-680-S**
790	400	956	390 x 240 x 420	90	**RWK 212-790-S**
910	450	1022	390 x 255 x 420	107	**RWK 212-910-S**
1100	630	1096	390 x 290 x 420	138	**RWK 212-1100-S**

Output Reactor

Features and benefits

- Reduction of drive output voltage dv/dt
- Reduction of motor temperature
- Increase of motor life
- Compact and economic open frame design
- Standard catalog reactors up to 1100A
- UL rated materials used

Output Reactor Ordering Information

Rated Current @ 40°C (A)	Typical drive power rating (kVW	Power Loss @ 25° C/50 Hz (W)	Dimensions (H x W x D) (mm)	Weight (kg)	Catalogue No.
4	1.5	22	max.115 x 100 x max.60	1.2	**RWK 305-4-KL**
7.8	3	25	max.115 x 100 x max.60	1.2	**RWK 305-8-KL**
10	4	30	max.115 x 100 x max.70	1.8	**RWK 305-10-KL**
14	5.5	34	max.135 x 125 x max.70	2.2	**RWK 305-14-KL**
17	7.5	38	max.135 x 125 x max. 75	2.5	**RWK 305-17-KL**
24	11	45	max.135 x 125 x max.75	2.5	**RWK 305-24-KL**
32	15	55	max.170 x 155 x max.95	3.9	**RWK 305-32-KL**
45	22	60	max.190 x 155 x max.110	6.1	**RWK 305-45-KL**
60	30	65	max.190 x 155 x max.125	6.1	**RWK 305-60-KL**
72	37	70	max.190 x 155 x max.125	6.1	**RWK 305-72-KL**
90	45	75	max.225 x 190 x max.115	7.4	**RWK 305-90-KL**
110	55	90	max.220 x 190 x max.130	8.2	**RWK 305-110-KL**
124	55	110	max.160 x 190 x max.180	8.2	**RWK 305-124-KS**
143	75	115	max.160 x 190 x max.180	10.7	**RWK 305-143-KS**
156	75	120	max.160 x 190 x max.180	10.7	**RWK 305-156-KS**
170	90	130	max.160 x 190 x max.180	10.7	**RWK 305-170-KS**
182	90	140	max.185 x 210 x max.180	16	**RWK 305-182-KS**
230	132	180	220 x 240 x 220	22	**RWK 305-230-KS**
280	160	220	220 x 240 x 235	29	**RWK 305-280-KS**
330	160	240	220 x 240 x 240	32	**RWK 305-330-KS**
400	200	330	325 x 240 x 220	34	**RWK 305-400-S**
500	250	340	325 x 240 x 220	35	**RWK 305-500-S**
600	355	380	325 x 240 x 230	37	**RWK 305-600-S**
680	400	410	325 x 240 x 230	38	**RWK 305-680-S**
790	450	590	355 x 300 x 218	43	**RWK 305-790-S**
910	500	740	355 x 300 x 228	49	**RWK 305-910-S**
1100	630	760	380 x 360 x 250	66	**RWK 305-1100-S**

Fuses

DIN Fuse base – Three Single Pole Bases (Open)

Rating (A)	DIN fuse size	Mounting	Catalogue No.
160	00	Backplate	**6500 1030**
		DIN rail	**6500 1130**

DFB DIN Fuse bases – IP 20 kit

To suit	No of poles	Catalogue No.
DFB	3	**6510 1030**

NH / DIN fuse links 500V AC

Length (mm)	Diameter (mm)	Current rating (A)	HRC fuse link size	Catalogue No.
78.5	20.5	50	00C [1])	**N00 50**
78.5	20.5	80	00C [1])	**N00 80**
78.5	20.5	100	00C [1])	**N00 100**
78.5	28	160	00	**N00 160**

6500 0033
Connecting block

6500 0001
Phase separation shield

6500 0010
Terminals shroud

6500 0020
Fuse cover

N00 _
gG general purpose fuse

Note: [1]) IP20 kits include fuse cover, shrouds, shields and connecting blocks

Service

Product repairs and service

When maintenance or repair work is required, NHP products are returned to our National Service Centre and when this is not possible, we deploy our field service technicians to complete the tasks at customer sites. NHP Service engineers will provide you with intimate knowledge of your products which will ensure peace of mind and optimisation of your operation.

CIRCUIT BREAKERS - MCCBs / ACBs

- Circuit breaker protect assets

VARIABLE SPEED DRIVES

- Ensure your VSD is configured correctly for your application
- Get your VSD up and running in minimum time
- Prevent unpredictable failure through regular servicing of the VSD
- Ensure seamless integration into existing systems

SOFT STARTERS

- Minimise your starting current
- Ease pressure on your power supply

POWER FACTOR CORRECTION

- Minimise risk of paying a tariff penalty
- Minimise risk of reduced current carrying capacity of your mains

LIQUID RESISTANCE STARTERS

- Ensure engineered resistance is at the optimal level
- Ensure the starting profile is perfectly suited for your application
- Inspect and adjust all mechanical and electrical components within the starters accordingly
- Ensure the starter I/O are interfacing with the site control system

Commissioning

Our field commissioning technicians work with you to understand your application and configure panels in accordance with your requirements. Pre-commissioning and witness tests can be accommodated prior to dispatch. On-site commissioning can also be arranged to suit your project requirements.

Emergency breakdown assistance

Disruption can result in costly losses and consequential damages. NHP service offers 24/7 protection to ensure consistency and efficiency of performance of your plant and equipment. Our service technicians are on call and are equipped to minimise downtime.

Preventative maintenance

Preventative maintenance can extend the life span of products and it is possible to predict failure before it occurs. All products have a finite lifespan. When products do fail, it can lead to costly repair or production losses. The NHP Service team can discuss your site requirements with you and develop a suitably structured maintenance program to suit your budget and contingency requirements.

CT'S – For PFC and AHF

Selection of CT's must be in line with manufacturer recommendations. Consult user manuals for further information.

Split Core Current Transformers

Types

	CTD-5S from 100A to 400A			
Class	1/ 3/			
Window size	26 x 32mm			
Accuracy class depending on the burden output	Burden (VA)			
Primary current output current of 1A/5A	Class	1	3	**Cat. No.**
	100A	-	1.5	**CTD 5S 100A**
	125A	1.5	1.5	**CTD 5S 125A**
	150A	1.5	2.5	**CTD 5S 150A**
	200A	1.5	5	**CTD 5S 200A**
	250A	1.5	5	**CTD 5S 250A**
	300A	2.5	7.5	**CTD 5S 300A**
	400A	5	10	**CTD 5S 400A**

CTD-6S from 150A to 1000A			
1/ 3/			
50 x 52mm			
Burden (VA)			
Class	1	3	**Cat. No.**
150A	-	1.5	**CTD 6S 150A**
200A	1.5	2	**CTD 6S 200A**
250A	1.5	3.75	**CTD 6S 250A**
300A	1.5	5	**CTD 6S 300A**
400A	2.5	5	**CTD 6S 400A**
500A	5	10	**CTD 6S 500A**
600A	7.5	15	**CTD 6S 600A**
700A	1.5	15	**CTD 6S 700A**
750A	1.5	15	**CTD 6S 750A**
800A	10	15	**CTD 6S 800A**
1000A	10	15	**CTD 6S 1000A**

	CTD-8S from 150A to 2500A			
Class	1/ 3/			
Window size	30 x 80mm			
Accuracy class depending on the burden output	Burden (VA)			
Primary current output current of 1A/5A	Class	1	3	**Cat. No.**
	150 A	-	1.5	**CTD 8S 150A**
	200A	-	1.5	**CTD 8S 200A**
	250A	-	2	**CTD 8S 250A**
	300A	-	2	**CTD 8S 300A**
	400A	3	5	**CTD 8S 400A**
	500A	5	7	**CTD 8S 500A**
	600A	6	10	**CTD 8S 600A**
	700A	6	10	**CTD 8S 700A**
	750A	8	12	**CTD 8S 750A**
	800A	8	12	**CTD 8S 800A**
	1000A	10	15	**CTD 8S 1000A**
	1200A	12	15	**CTD 8S 1200A**
	1250A	12	15	**CTD 8S 1250A**
	1500A	15	20	**CTD 8S 1500A**
	1600A	15	20	**CTD 8S 1600A**
	2000A	20	25	**CTD 8S 2000A**
	2500A	25	30	**CTD 8S 2500A**

CTD-9S from 400A to 4000A			
1/ 3/			
35 x 125mm			
Burden (VA)			
Class	1	3	**Cat. No.**
400A	-	3	**CTD 9S 400A**
500A	2	4	**CTD 9S 500A**
600A	4	6	**CTD 9S 600A**
700A	4	8	**CTD 9S 700A**
750A	4	8	**CTD 9S 750A**
800A	4	8	**CTD 9S 800A**
1000A	6	10	**CTD 9S 1000A**
1200A	8	12	**CTD 9S 1200A**
1250A	8	12	**CTD 9S 1250A**
1500A	10	15	**CTD 9S 1500A**
1600A	10	15	**CTD 9S 1600A**
2000A	15	20	**CTD 9S 2000A**
2500A	20	25	**CTD 9S 2500A**

CTD-10S from 400A to 4000A			
1/ 3/			
50 x 126mm			
Burden (VA)			
Class	1	3	**Cat. No.**
400A	1	7	**CTD 10S 400A**
500A	3	10	**CTD 10S 500A**
600A	5	12	**CTD 10S 600A**
700A	8	15	**CTD 10S 700A**
750A	10	15	**CTD 10S 750A**
800A	10	15	**CTD 10S 800A**
1000A	12	20	**CTD 10S 1000A**
1200A	15	25	**CTD 10S 1200A**
1250A	15	25	**CTD 10S 1250A**
1500A	20	30	**CTD 10S 1500A**
1600A	20	30	**CTD 10S 1600A**
2000A	25	40	**CTD 10S 2000A**
2500A	30	50	**CTD 10S 2500A**
3000A	30	50	**CTD 10S 3000A**
3200A	30	50	**CTD 10S 3200A**

Note: all the products are CE marked.

* Limited sizes available from NHP stock, others on indent basis.
Please contact NHP representative for advice

CT'S – For PFC and AHF

Selection of CT's must be in line with manufacturer recommendations. Consult user manuals for further information.

Standard Current Transformers

Accuracy class
Ratio:
Primary/Secondary current 5 A or 1A

TAI BB - Cable Ø 21mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
-	-	1	**TAI BB 40 /**
-	1.25	1.5	**TAI BB 50 /**
-	1.25	2	**TAI BB 60 /**
-	1.5	2.5	**TAI BB 75 /**
-	1.5	2.5	**TAI BB 80/**
2	2.5	3.5	**TAI BB 100 /**
2.5	3.5	4	**TAI BB 120 /**
3	4	5	**TAI BB 150 /**
4	5.5	6	**TAI BB 200 /**
5	6	7	**TAI BB 250 /**
6	7.5	8	**TAI BB 300 /**

TA 327 - Cable Ø 27mm Busbar 32 x 10mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
-	-	1.5	**TA 327 40 /**
-	-	2.5	**TA 327 50 /**
-	-	2.5	**TA 327 60 /**
-	1.5	3.5	**TA 327 75 /**
-	1.5	4	**TA 327 80/**
-	2.5	5	**TA 327 100 /**
-	3.5	5.5	**TA 327 120 /**
1.5	5.5	6.5	**TA 327 150 /**
4	7	8.5	**TA 327 200 /**
6	9	11	**TA 327 250 /**
7.5	11	13.5	**TA 327 300 /**
10.5	15	18	**TA 327 400 /**
12	18	22	**TA 327 500 /**
14.5	21.5	26	**TA 327 600 /**

TA 432 - Cable Ø 32mm Busbar 40 x 10mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
1	3	6	**TA 432 150 /**
1.5	3	6	**TA 432 200 /**
2.5	5	8	**TA 432 250 /**
4	8	12	**TA 432 300 /**
8	12	15	**TA 432 400/**
10	12	15	**TA 432 500 /**
12	15	15	**TA 432 600 /**
10	12	15	**TA 432 750 /**
10	12	15	**TA 432 800 /**
10	12	15	**TA 432 1000 /**

Accuracy class
Ratio:
Primary/Secondary current [1])

TAS 65 - Busbar 63 x 32mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
8	10	12	**TAS 65 500 / 5A**
8	12	15	**TAS 65 600 / 5A**
10	15	15	**TAS 65 750 / 5A**
12	15	20	**TAS 65 800 / 5A**
15	20	25	**TAS 65 1000 / 5A**
15	20	25	**TAS 65 1200 / 5A**
20	25	30	**TAS 65 1500 / 5A**

TAS 102 - Busbar 100 x 38mm (max.)		
CL 0.5 VA	CL 1 VA	Cat. No.
10	12	**TAS 102 1000 / 5A**
12	15	**TAS 102 1200 / 5A**
12	15	**TAS 102 1500 / 5A**
20	25	**TAS 102 2000 / 5A**
20	25	**TAS 102 2500 / 5A**
20	25	**TAS 102 3000 / 5A**

TAS 127B - Busbar 125 x 52mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
20	30	40	**TAS 127B 1500 / 5A**
20	30	40	**TAS 127B 1600 / 5A**
25	40	50	**TAS 127B 2000 / 5A**
30	50	60	**TAS 127B 2500 / 5A**
40	60	60	**TAS 127B 3000 / 5A**
50	60	60	**TAS 127B 4000 / 5A**

Accuracy class
Ratio:
Primary/Secondary current [1])

TAS 65 - Busbar 63 x 32mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
8	10	12	**TAS 65H 500 / 5A**
8	12	15	**TAS 65H 600 / 5A**
10	15	15	**TAS 65H 750 / 5A**
12	15	20	**TAS 65H 800 / 5A**
15	20	25	**TAS 65H 1000 / 5A**
15	20	25	**TAS 65H 1200 / 5A**
20	25	30	**TAS 65H 1500 / 5A**

TAS 102 - Busbar 102 x 38mm (max.)		
CL 0.5 VA	CL 1 VA	Cat. No.
10	12	**TAS 102H 1000 / 5A**
12	15	**TAS 102H 1200 / 5A**
12	15	**TAS 102H 1500 / 5A**
20	25	**TAS 102H 2000 / 5A**
20	25	**TAS 102H 2500 / 5A**
20	25	**TAS 102H 3000 / 5A**

TAS 127B - Busbar 125 x 52mm (max.)			
CL 0.5 VA	CL 1 VA	CL 3 VA	Cat. No.
20	30	40	**TAS 127BH 1500 / 5A**
20	30	40	**TAS 127BH 1600 / 5A**
25	40	50	**TAS 127BH 2000 / 5A**
30	50	60	**TAS 127BH 2500 / 5A**
40	60	60	**TAS 127BH 3000 / 5A**
50	60	60	**TAS 127BH 4000 / 5A**

Note: Horizontal and vertical mount available
[1]) CT's available as 1A secondary on request.

MCCB selection guide for power factor capacitor application

Voltage 415V (3 Ph)						
Capacitor Rating (kVAr)	Capacitor Rated Current (A)	Recommended MCCB [1] [2] (type/rating (A))				
5	7			**E125NJ/20**	**S125NJ/20**	**S125GJ/20**
10	13.9			**E125NJ/32**	**S125NJ/32**	**S125GJ/32**
15	20.9			**E125NJ/50**	**S125NJ/50**	**S125GJ/50**
20	27.8			**E125NJ/50**	**S125NJ/50**	**S125GJ/50**
25	34.8			**E125NJ/63**	**S125NJ/63**	**S125GJ/63**
30	41.7			**E125NJ/100**	**S125NJ/100**	**S125GJ/100**
40	55.6			**E125NJ/100**	**S125NJ/100**	**S125GJ/100**
50	69.6			**E125NJ/125**	**S125NJ/125**	**S125GJ/125**
75	104	**E250NJ/160**	**S160NJ/160**	**S160GJ/160**		
100	139	**E250NJ/250**	**S250NJ/250**	**S250GJ/250**	**S400NE/250**	**S400GE/250**
150	209		**S400CJ/400**	**S400NJ/400**	**S400NE/400**	**S400GE/400**
200	278		**S400CJ/400**	**S400NJ/400**	**S400NE/400**	**S400GE/400**
300	417		**S630CE/630**	**S630GE/630**	**S630GE/630**	**S630GE/630**
400	556	**S800NJ/800**	**S800NE/800**	**S800RE/800**		
500	696	**S1250SE/1250**				
600	835	**S1250SE/1250**				
800	1113	**S1600NE/1600**				
1000	1391	**XS2000NE/2000**				

Notes: [1]) Select applicable short circuit rating required by system specifications.
[2]) MCCBs can be changed to electronic types if required.

Examples for Circuit Breaker on Mains side of AHF

Active Harmonic Filter Type	Example Terasaki Circuit Breaker	Circuit Breaker setting of thermal trip current Ir (A)
30A / 50 A 3 wire	**S125NJ**	80
30A / 60 A 4 wire	**S125NJ**	100
100A 3+4 wire	**S160NJ**	160
120A 3+4 wire	**S250NJ**	200
300A 3+4 wire	**S400NJ**	400

Power Factor Correction

Power factor - What does it mean

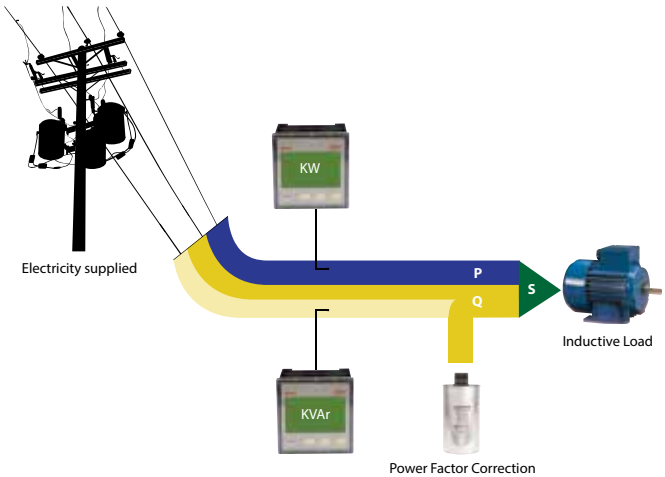
One very important aspect of improving quality of supply is the control of power factor. Low power factor means poor electrical efficiency. The lower the power factor, the higher the apparent power drawn from the distribution network. This means that the supply company must install larger generation capacity, larger size transmission lines and cables, transformers and other distribution system devices, which otherwise would not be necessary. This results in a much higher capital expenditures and operating costs for the Electricity Supply Company, which in many cases is passed on to the consumer in the form of higher tariff rates.

This is the main reason behind why the Electricity Supply Companies in modern economies demand reduction of the reactive load in their networks via improvement of the power factor. In most cases, special reactive current tariffs penalize consumers for poor power factors.

Electrical Load Types

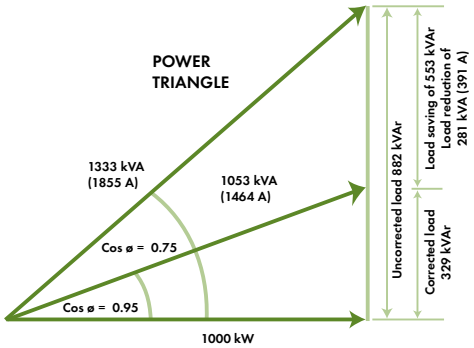
Loads on an electrical distribution system can be categorized as resistive, inductive and capacitive. Under normal operating conditions certain electrical loads (e.g. transformers, induction motors, welding equipment, arc furnaces and fluorescent lighting) draw not only active power (kW) from the supply, but also inductive reactive power (kVAr).

All inductive loads require active power: kW to actually perform the work, and reactive power (kVAr) to maintain the electromagnetic field. This reactive power is necessary for the equipment to operate but it imposes an undesirable burden on the supply.



Displacement, distortion and total power factor

Displacement power factor is defined as the ratio between apparent power (at the fundamental frequency) and real power. Or, in other words $PF_{displacement} = \cos(\theta)$, where θ is the phase shift between voltage and current at the fundamental frequency. Therefore, inductive loads such as induction motors will affect the displacement power factor. When the load is inductive, the inductance tends to oppose the flow of current, storing energy then releasing it later in the cycle. The current waveform lags behind the voltage waveform. When the load is capacitive, the opposite occurs, and the current waveform leads the voltage waveform. So, lagging vs. leading is another way of saying the net reactance is either inductive or capacitive.



Distortion power factor is the ratio between the current at the fundament frequency and the total current. As shown below, distortion power factor can be shown to be a function of total harmonic current distortion (THID):

$$i.e. \quad PF_{Distortion} = \frac{I_{\text{Fundamental}}}{I_{\text{Total}}}$$

$$As \quad THID = \frac{I_{harmonic}}{I_{fundamental}} \times 100$$

$$PF_{Distortion} = \sqrt{\frac{1}{1 + THID^2}}$$

Distortion power factor can be improved by reducing the current harmonic distortion. There are many different ways of mitigating harmonics, which will be application dependant. For example, passive harmonic filters are specifically designed to mitigate harmonics produced by a 6 pulse variable speed drive (VSD).

The total power factor of a load is defined as the ratio of active power to apparent power, i.e. kW divided by kVA. This ratio is a function of both displacement power factor and distortion power factor. Therefore total power factor can be improved by reducing reactive power (kVAr) consumption (i.e. installation of PFC system) as well as through harmonic mitigation (i.e. harmonic filters). The degree to which has the greater influence depends upon the loads installed.

The benefit of installing Power Factor Correction systems

Power factor correction (PFC) systems can be used as a central, group or individual reactive compensation system for low voltage applications. The installation of a PFC system can provide many advantages including:

- Reducing energy costs when billed with a kVA demand charge
- Increased utilization of energy resources
- Decreased substation and sub-mains load
- Lower system losses
- Enhanced voltage regulation

How much will PFC save you?

Power factor correction is an investment that helps to improve company's profit performance. The following is an example to illustrate the savings by installing power factor correction equipment.

Let us assume that the penalty is 37.57 cents per day per kVAr, for the kVAr necessary to improve the power factor to 0.95 lagging.

1000 kW load at a PF of 0.75 = 882 kVAr

1000 kW load at pf of 0.95 = 329 kVAr

The extra kVAr drawn from the supply is:

882 kVAr – 329 kVAr = 553 kVAr

553 x 37.57 = $207.76 penalty per day

Assume the Power factor correction unit will cost installed about $60 per kVAr

Therefore 600 kVAr x $60 = $36,000

Payback period = $36'000 divided by $207.76 = 173 days or about five to six months.

In about 5 to 6 months the cost for power factor correction is recovered and any further penalties are avoided for the life of the electrical installation. Any further savings then become profits that add to the company's bottom line.

Note: This example is for illustration purposes only. Actual savings will vary from installation to installation.

General PFC Design Principles

In the design of a PFC system there are a number of issues that must be addressed to ensure correct and reliable operation. The most vulnerable component in all PFC systems is the capacitor. Even though capacitors have integral protection, various environmental conditions (eg. excessive temperature, overvoltage, harmonic distortion) may cause the capacitor to rupture and ignite. It must therefore be ensured, by necessary design measures, that they do not form any hazard to their environment in the event of failure or malfunction of the safety mechanism.

With this in mind, NHP recommends that all PFC systems are constructed as a separate, stand-alone assembly. If a separate, stand-alone assembly is not possible, appropriate measures should be taken to ensure the PFC system is self contained within the overall construction of the main switch board. These measures are recommended to limit the possibility that failed capacitors affect equipment in the vicinity of the PFC, potentially damaging components in other sections of the main switchboard.

Temperature:

The average life span of a capacitor is heavily dependant on the ambient temperature in which it is operated. The permissible operating temperatures of the Electronicon capacitors is -40 °C up to IEC831-1 temperature class C or D (the table of IEC831-1 temperature classes is shown below). The choice of temperature class C or D relates to the maximum useful operating life you can expect to receive from the capacitor given the environment in which it is operated. For the Electronicon capacitor, the maximum useful operating life is 130,000 hours when operated in temperature class C conditions, and 100,000 hours when operated in temperature class D conditions.

TEMPERATURE CLASS	AMBIENT TEMPERATURE LIMIT		
	Max.	Max. average over 24 hours	Max. average over 365 days
B	45 °C	35 °C	25 °C
C	50 °C	40 °C	30 °C
D	55 °C	45 °C	35 °C

To ensure that the appropriate IEC temperature class is maintained, NHP recommend that two thermal relays are incorporated into every design: one thermal relay set to 35 °C to activate forced ventilation; and one thermal relay set to 50 °C to isolate the power to the capacitors. Whilst the capacitor is capable of operating up to 55 °C to achieve temperature class D, NHP recommends that the over-temperature cutout be set to 50 °C to maintain a safety margin and protect against hotspots that can occur within an enclosure.

Reactors are a high watts loss device. The NHP Functional Tray design incorporates efficient heat dissipation principles however, care must be taken when capacitors are enclosed near heat producing items such as reactors. When capacitors are subjected to excessively high temperatures their life expectancy is greatly reduced. Adequate cooling fans and ventilation grills must be included in power factor enclosures to ensure the temperature rise does not exceed limits. NHP recommends a design parameter of 5 W / kVAr heat dissipation on systems where harmonics may be present.

Influence of harmonic distortion on capacitors

Harmonics in the mains supply can adversely affect any electrical equipment. Power factor correction equipment is no different.

The harmonics lead to a higher capacitor current, because the reactive resistance of a capacitor reduces with rising frequency. The rising capacitor current can be accommodated by constructional improvements in the manufacture of the capacitor. However a resonating circuit between the power factor correction capacitors, the inductance of the feeding transformer and the mains may occur. If the frequency of such a resonating circuit is close enough to a harmonic frequency, the resulting circuit amplifies the oscillation and leads to immense over-currents and over-voltages.

Harmonic distortion of an AC supply can result in any or all of the following:

- Premature failure of capacitors.
- Nuisance tripping of circuit breakers and other protective devices.
- Failure or malfunction of computers, motor drives, lighting circuits and other sensitive loads.

The installation of detuned (reactor-connected) capacitors is designed to force the resonant frequency of the network below the frequency of the lowest harmonic present, thereby ensuring no resonant circuit and, by implication, no amplification of harmonic currents. This differs from a close-tuned filter circuit, which is tuned to a certain harmonic frequency and presents a very low impedance to the individual harmonic current, diverting the majority of the current into the filter bank rather than the supply. An example of this type of arrangement is a passive harmonic filter.

All NHP PFC systems are fitted standard with reactors de-tuned to 189 Hz standard, i.e. blocking 5th order harmonics and above. The NHP PFCE systems are also available with de-tuned capacitor banks at 134 Hz to block 3rd order harmonics and above.

We strongly advise to conduct a comprehensive mains analysis, including measurement of the harmonic content, before designing and installing your power factor correction equipment.

Harmonics

What are harmonics?

The term "harmonics" refers to the voltage and current harmonic distortion within an AC circuit. Any waveform which is not sinusoidal (complex) can be shown to contain sinusoidal waveforms of integer multiples of the fundamental. In a 50 Hz electrical system, 250 Hz is the 5th harmonic, 350 Hz is the 7th harmonic etc.

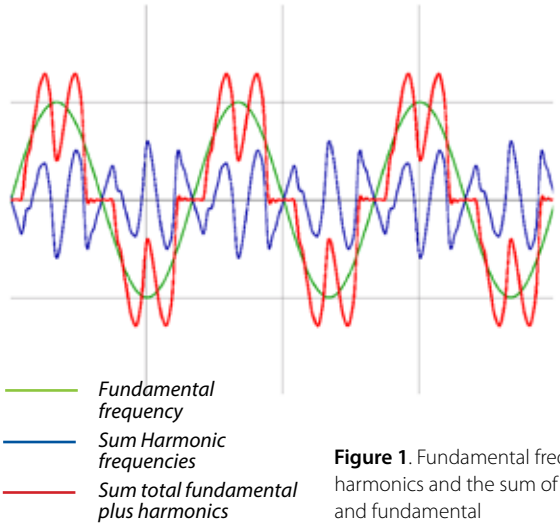


Figure 1. Fundamental frequency, harmonics and the sum of harmonics and fundamental

An electrical system supplies power to loads by delivering current at the fundamental frequency. Only fundamental frequency current can provide real power. Current delivered at harmonic frequencies do not deliver any real power to the load. The percentage of harmonics in a waveform is called THD (total harmonic distortion) and can be further broken up into THVD (total harmonic voltage distortion) and THID (total harmonic current distortion). As the THVD and THID increases, the efficiency of the system is greatly reduced.

$$THID = \frac{I_{harmonic}}{I_{fundamental}} \quad X\ 100$$

Harmonic currents create harmonic voltages and it is the harmonic voltages that cause the problems with other equipment that are connected to the same secondary of the transformer where the harmonic originated.

Harmonics are created by the increased use of non-linear devices such as UPS systems, solid state variable speed motor drives, rectifiers, welders, arc furnaces, fluorescent ballasts, and personal computers. The current drawn by these devices is not proportional to the supplied voltage, this such loads are referred to as non-linear loads.

Problems caused by harmonics

High voltage distortion, current distortion and high neutral-to-ground voltage caused by harmonics can result in equipment failure, production down time and costly repairs to the electrical distribution network.

It is critical that the consumer is aware of the costly problems and hazards associated with high levels of harmonics especially given the dramatic increase in use of non linear devices. These harmonics can greatly impact the electrical distribution network along with all facilities and equipment that are connected.

Main problems associated with harmonics include:

- Overheating of standard electrical supply transformers
- Conductor losses (skin effect)
- Poor power factor
- Resonance which produces over-current surges.
- Large load currents in the neutral wires of a 3 phase system.
- Interference in telecommunications systems and equipment
- Erratic operation of control and protection relays
- Malfunction of computers, motors, lighting circuits and other sensitive loads
- Tripping of circuit breakers and other protective devices
- Harmonic voltage distortion affecting neighbouring facilities

For more information regarding harmonics and associated problems please refer to Technical News Article #64 – Part 1: Harmonics. Where they come from, the problems they cause and how to reduce their effects

What are acceptable harmonic limits?

Local and international standards including the AS/NZS 61000 series and the widely recognized IEEE 519 standard are sources readily referenced in Australia and New Zealand for harmonic distortion limits. Some supply authorities enforce their own specific current and/or voltage harmonic limits, sometimes in conjunction with local and international standards.

Harmonic Mitigation Solutions

A number of methods have been used to minimize the effects of harmonics on the network and connected equipment. Some methods involve over-sizing or de-rating of the installation or using phase shifting transformers, while reactors and harmonic filters are widely available and can be a much easier and cost effective solution.

Five common methods to mitigate harmonics caused by a VSD include:

- Reactors (AC line chokes or DC link chokes)
- Multi-pulse solutions
- Active Front End
- Passive Harmonic Filters
- Active Harmonics Filters

For more information regarding variable speed drives and multi-pulse and active front end solutions please refer to Technical News Article #59 – Drives: benefits, operation, pitfalls and harmonic solutions.

Passive Harmonic Filters

The Schaffner range of PHF's (ECOsine™ harmonic filters) are designed for the operation on the line side of power electronic equipment with 6-pulse rectifier front ends in balanced three-phase power systems. These units are tuned to target the 5th and 7th harmonics, which are predominately caused by 6 pulse VSD's. Since these devices are connected in line with the VSD they must be rated for full load current (FLC). An unfiltered VSD may produce anywhere between 80-120% THID. Schaffner ECOsine™ PHF's can reduce THID levels of a VSD to 5%.

Active Harmonic Filters

The Schaffner Active Harmonic Filters (ECOsine™ Active) differ significantly from Passive Harmonic filtering technology in application, function and features. The AHF's are connected in parallel to loads/network and are highly sophisticated microprocessor based devices which monitors the network continuously and "inject" compensating current to mitigate harmonics. As such, these units are ideal for applications involving varying load conditions as it will adjust the compensating current to achieve the desired level of current harmonic distortion.

Another key difference is that AHF's are not limited to 6 pulse VSD applications. The Schaffner AHF's can improve THID levels to within 1.5-3% for any harmonic producing load including single phase and three phase non-linear loads. These units also offer the ability to target specific harmonics up to the 49th harmonic as well as reactive power compensation (PFC) and load balancing.

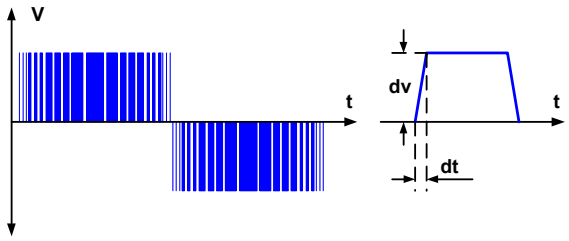
Output solutions for motor drives

There are important technical considerations for the motor when using a VSD due to the modulated signal supplied and other factors such the use of shielded or non-shielded motor cable and length of motor cable etc. Some of the typical output challenges are described below.

Problems at the VSD output

1. dv/dt – Voltage rise in relation to time

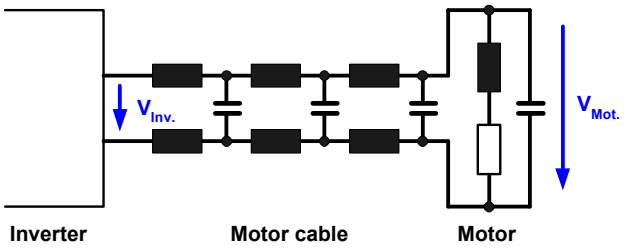
To keep the losses in the frequency converter, the aim is to keep the switching times of the power semiconductors as short as possible. The result of this is that with the newest generation of IGBTs, rise times of sometimes more than 12kV/µs can be measured, whereas – depending on the motor – a dv/dt of <1000V/µs is considered permissible (VDE 0530: 500 to 1000V/µs).

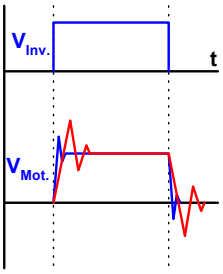


Where short motor cables up to about 20m are used, these rise times can act fully on the insulation of the motor windings due to the small line impedance. This dv/dt stress load leads to premature aging and thus to a reduction in the life of the motor.

2. Voltage spikes

Parasitic capacitance by the motor exists due to the structure of the windings. With every additional meter of motor cable, more wire inductance is added to this structure. When subject to voltage pulses, voltage peaks occur every time switching on or off takes place. The longer the motor cable, the greater the peak voltage. These amplitudes can reach values that cause stress in the winding insulation of the connected motor. With longer cable runs (and added impedance), the dv/dt stress is reduced, however peak values of 1600V or more (depending on the DC link voltage) can occur due to cable reflections – see image on right. According to VDE 0530, peak values of <1000V are recommended





10m cable / 100m cable

Additional losses in the motor.

Harmonics are created on the output signal as a result of the steep switching edges. The steeper these pulses the more harmonic content there is. The current ripple (pulse width modulated signal including harmonics) results in additional magnetic losses in the motor. The permanent increase in operating temperature of the motor can result in reduced operating life.

Bearing damage

Bearing damage can occur due to the bearing currents that result from the shaft voltage. The shaft voltage (or rotor voltage) is induced in the motor shaft due to the differences in the flux densities of the stator and rotor. As the voltage builds up a compensating current will flow towards the earth and the path of least resistance in this instance is through the motor bearings. This bearing current, over a long period of time, will result in drying of the bearings (i.e. lubricant film in the bearing) and thus failure of the motor. It is possible to counter this phenomenon to a certain degree through the use of ceramic bearings.

Bearing damage can also occur due to the bearing voltage (which is a product of the capacitive coupling between the motor housing, the stator and the rotor) and flashovers from resulting current flow which leaves behind small pits on the surface of the bearing. The running of the bearing becomes increasingly rough because of the damaged surface and the life is thus considerably shortened. Typically, the bearing voltage is between 10 and 30V. But since it is directly dependent on the mains supply voltage, bearing damage increases proportionally at higher supply voltages.

In the case of unshielded motor cables, the cable capacitance and consequent current is relatively small. The parasitic capacitances on the inside of the motor dominate. Ideally, the parasitic currents flow through the motor housing to the ground. However, if the grounding of the motor is inadequate, the additional impedance will mean the potential at this point increase sharply. The values of the bearing currents also increase greatly and will flow fully through the bearings to the earth. When this occurs, the life expectancy of the ball bearings (and hence of the entire motor), is significantly reduced (possibly to a few hours).

Solutions for output problems

To combat the range of problems that can affect a motor when operated by a variable speed drive, the following options are available:

dv/dt chokes (RWK 305)

A dv/dt choke is usually the first step considered to protect the motor from high output voltage dv/dt from VSDs. By adding additional inductance in line with the motor and the output terminal of the VSD, the dv/dt chokes reduce the drive output voltage dv/dt and hence reduces motor operating temperature. Added benefits include protection of motor coil insulation from premature ageing and destruction and increased reliability and service life of electric motors. Typically the maximum motor cable length when using a dv/dt choke is 30 metres. When longer motor cables are used and/or additional protection is required a sine wave filter is the next option to consider.

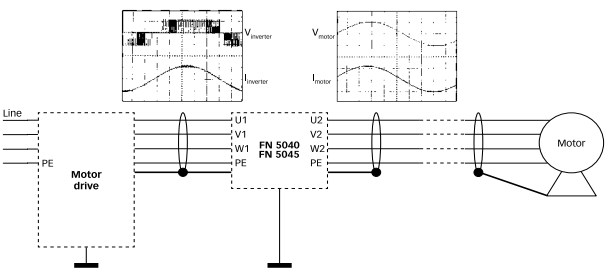
Sine wave filters (FN5040)

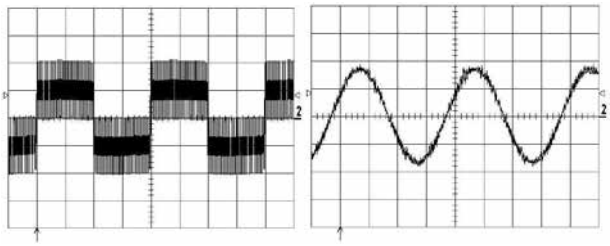
Traditional symmetric sinusoidal output filters are connected directly to the converter output and convert the PWM signal of the frequency converter between the phases into a smooth sinusoidal curve.

Symmetric sinusoidal output filters are have the following advantages:

- Complete protection of the motor from dv/dt and overvoltages
- Reduction of the additional magnetic losses and eddy current losses in the motor
- Reduction of the additional losses of the frequency converter owing to lower pulse currents to earth
- Reduction of the acoustic noise of the motor
- Reduction of the interference potential coming from shielded motor cables
- Increase in the reliability and operational safety of the overall system
- Maximum motor cable length ranges from 200 m up to 2000 m depending upon the size of the motor (refer to FN5040 data sheet for max. motor cable length curve)

Typical block schematic

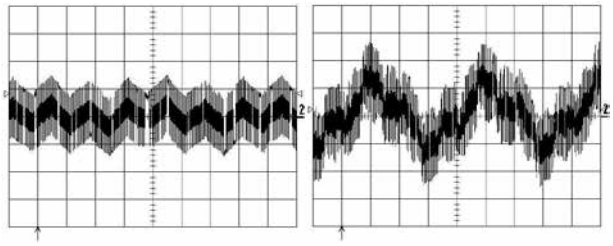




A B

Curve A: Inverter output U_{P-P}

Curve B: Signal at the motor afterthe sym. sinusoidal filter U_{P-P}



A B

Curve A: Inverter output U_{P-E}

Curve B: Signal at the motor after the sym. sinusoidal filter U_{P-E}

As seen in the above traces, the sine wave filter significantly improves the differential mode noise. There is only small improvement in the common mode noise (P-E). Common mode noise can cause the following issues:

- Bearing damage
- Parasitic earth currents
- Necessity of shielded motor cables
- Limited maximum possible motor cable length

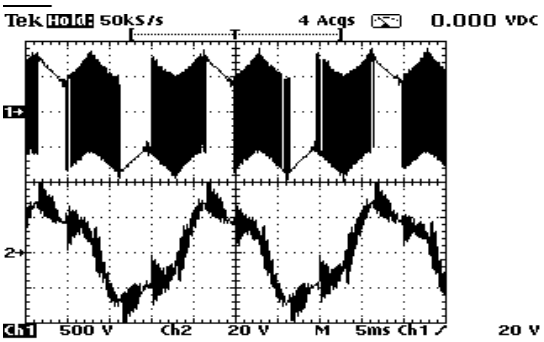
A sine wave filter plus additional module (FN5030) can be used to reduce the common mode noise.

Sine Wave Filter Plus – Add on module (FN5030) to be used with the sine wave filter FN5040

Sine Wave Filter Plus (Sinus Plus) is a highly developed modular sinusoidal filter concept from Schaffner that is unique in the market today. Through innovative circuits and an additional connection to the DC link, the additional module is capable of sending the asymmetric interferences directly to the very place they originated.

Using the FN5040 and FN5030 together results in the following additional advantages:

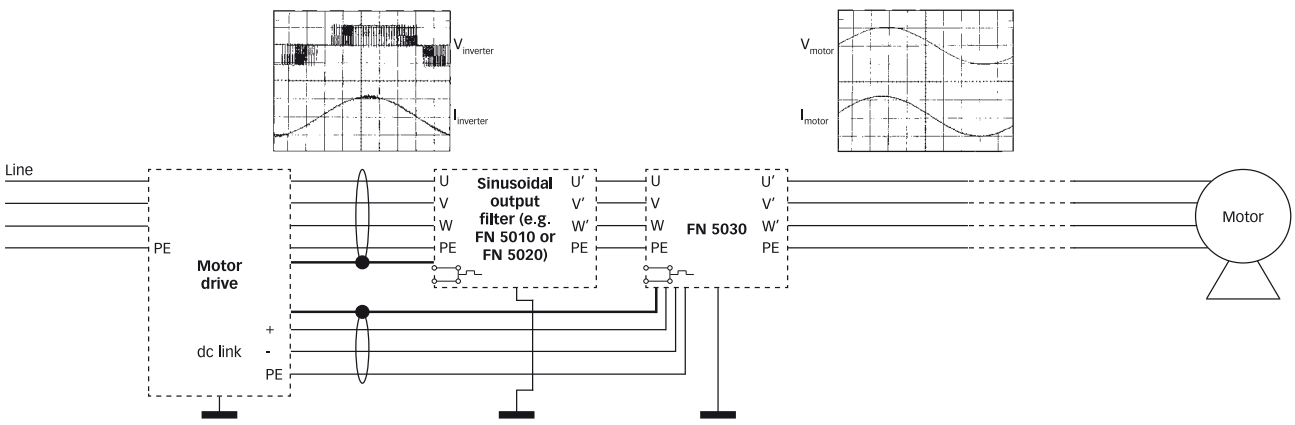
- Complete elimination of bearing damage
- The possibility of using unshielded motor cables without any reductions in immunity
- Practically no more limitations with regard to the maximum cable length
- Almost complete elimination of the pulse currents to earth
- No interference influence of neighboring cables and equipment
- Elimination of the additional losses in the frequency converter
- Reduction in the suppression efforts on the input side.



Curve 1: Inverter output $U_{P\text{-}E}$

Curve 2: Signal at the motor, after both sinusoidal filters $U_{P\text{-}E}$

Typical block schematic



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